Combined in-situ spectroscopic and electrochemical studies of interfacial and interphasial reactions during adsorption and de-adhesion of polymer films on metals

Abstract

Water and solvent borne epoxy-amine polymers on steel substrates were observed at high humidity and in corrosive environment. Water borne epoxy-amine polymers are preferred in corrosion protection due to reduced application of harmful educts during production and low emission of volatile organic compounds during application. The aim of this study is to understand the effect of the bulk structure and the interface structure on adhesion and on the behaviour in humid environment.

The corrosion mechanism at water borne epoxy-amine polymer/steel interfaces was found to differ from previously studied systems. Cations and anions of a polymer defect are transported into the polymer/substrate interface due to capillary forces induced by high swelling and high water activity at the water borne polymer/steel interface. Water uptake and diffusion strongly influence the corrosive reaction and were reduced by addition of the adhesion promoting organosilane glycidoxypropyl(trimethoxy)silane.

Chemical changes at the polymer/substrate interface were further studied by in-situ backside surface enhanced Raman spectroscopy. Thereby it was shown that the diffusion of the corrosion inhibitor mercaptobenzimidazole is highly sensitive towards treatment of the polyelectrolyte coating. Further, a deeper understanding of oxidative degradation at the polymer/metal interface during corrosion reactions was gained.